

where B doesn't depend on \vec{r} since A_s 's don't depend on \vec{r} .
 But the average concentration at location \vec{r} is proportional to the probability to be at \vec{r} , so

$$n \propto e^{-U(\vec{r})/\tau} \quad \text{as required.}$$

Now, in our problem, $U(\vec{r}) = -\frac{GM_{\text{Earth}}}{r}$

Also, since on the surface $F = Mg = \frac{GM_{\text{Earth}}}{R^2}$, we can replace

$\cdot GM_{\text{Earth}}$ by gR^2 , so that $U(\vec{r}) = -\frac{MgR^2}{r}$

So $n(\vec{r}) = \text{const } e^{\frac{MgR^2}{r}}$ and we are given

$$n_0 \equiv n(R) = \text{const } e^{\frac{MgR}{R}}, \text{ so that}$$

$$n(\vec{r}) = n_0 e^{-\frac{MgR}{R}} e^{\frac{MgR^2}{r}}$$

We integrate the concentration to find the total number of particles:

$$\begin{aligned} N &= \iiint n(\vec{r}) dV = \iiint n_0 e^{-\frac{MgR}{R}} e^{\frac{MgR^2}{r}} r^2 dr d\theta d\varphi = \\ &= n_0 e^{-\frac{MgR}{R}} \int_0^{2\pi} d\varphi \int_0^\pi d\theta \int_R^\infty e^{\frac{MgR^2}{r}} r^2 dr = \\ &= 4\pi n_0 e^{-\frac{MgR}{R}} \int_R^\infty r^2 e^{\frac{MgR^2}{r}} dr \quad \text{as required.} \end{aligned}$$